Understanding the impact of feedstock variation

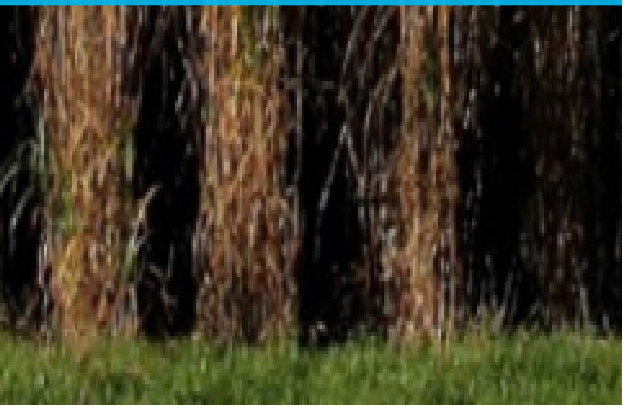
Snapshot

Client
Energy Technologies Institute

Challenge
To understand how the chemical properties of different biomass feedstocks vary; according to which part of the plant they are and where and how they are grown and stored.

Solution
We analyzed multiple samples of four different types of biomass species from across the UK under various planting, growing, harvesting and storage conditions. Using the results, we gauged the potential implications for biomass plant operators and feedstock growers.

Benefits
Operators of biomass-fired energy plant now have valuable data to inform the sourcing of feedstock from the point of view of the potential impact on plant efficiency, reliability and environmental emissions. This database has significant benefits over the usual resource (Phyllis2) in that the provenance of the samples taken is listed as well as the properties.



As biomass becomes an increasingly important energy source, the choice of feedstock is a key decision for plant operators. Our research has highlighted significant differences between the main feedstock types across the UK and how their differing composition could impact on energy plant operations and compliance aspects.

Supporting biomass expansion

As part of its support for the expansion of biomass energy, the Energy Technologies Institute (ETI) – an industry and UK government partnership for low-carbon development – commissioned Forest Research and Uniper to find out how and why biomass feedstock crops and plant parts may vary.

Four species were assessed: miscanthus grass, willow short rotation cycle (SRC), poplar short rotation forestry (SRF) and SRC, and conifer SRF.

Improving energy industry understanding

We analyzed samples from 54 field sites across the UK. Four different species and up to four plant parts were collected. Other variables we considered included growing conditions, soil type, harvest times and storage duration and methods. Chemical data were also compared to those from commercial pellet samples.

The results help to fill a gap in the energy industry's understanding of how variations in the composition of feedstocks can significantly affect their conversion to power or heat.

Key conclusions

- Different feedstocks and plant parts can vary significantly in their fuel potential.
- Levels of unwanted elements such as nitrogen, potassium, and chlorine can differ significantly between biomass parts – leaves, bark, stems – and species.
- Understanding what your composted green wood waste feedstock consists of could be important in limiting unwanted elements in boiler systems, risking component damage and environmental issues.
- Storage of woody biomass, whether covered or uncovered, largely improves fuel quality.
- Later harvesting of miscanthus reduces moisture, ash content, chlorine and potassium levels also improves fuel quality.

Implications for energy plants

Miscanthus as well as willow SRC and poplar leaves showed significant levels of chlorine - a potential factor in acid gas emissions and boiler corrosion. Feedstock buyers should check the levels of leaf material and specify harvesting times and storage to minimize these levels.

Potassium compounds found in ash for some feedstocks have important implications as the element is linked to a number of boiler issues including slagging, fouling and corrosion.

Levels of sulphur and nitrogen were low compared to typical UK coal values. Trace metals such as mercury, cadmium, lead and zinc were also below risk levels.

Miscanthus pellets evaluated during the project had elevated sodium levels which would have severe consequences in terms of corrosion and fouling.

The ETI's whole energy system analysis highlights the valuable role bioenergy can potentially play in cost-effectively meeting the UK's emission reductions targets.

Miscanthus storage in open-sided building

The results from this project provide a valuable dataset for biomass operators to understand the characteristics of these feedstocks, their variability and the steps that could be taken during growing and harvesting to improve them.

Geraint Evans
Programme Manager - Bioenergy, ETI

We analyzed

- Four climate regions
- Four different species
- Four different plant parts for SRF, SRC species
- Three harvest times
- Three storage times and methods
- 216 pellet samples
- Compared "in field" samples to assess potential variations

Leaves or branches?

Our research has confirmed that the part of the feedstock plant being used – leaves, stem, bark or branches – will have a significant effect on its energy value and chemical composition. All samples of SRC and SRF were considered except miscanthus as the separation of its leaves and stems is not commercially feasible, and occurs naturally if left to senesce before harvesting.

Because of the way plants grow, the concentration of chemical elements in different plant parts varies according to the season. Similarly, we found that the calorific value varies across the different plant parts.

For example, the chemical content of conifer SRF bark was lower than expected. However conifer leaves and tops typically had higher levels of unwanted elements such as nitrogen and chlorine, metals, and a high alkali index.

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